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SOLAR/2012-79/03

Monthly Performance Report

BELL TELEPHONE OF PENNSYLVANIA

MARCH 1979



U.S. Department of Energy

National Solar Heating and
Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT
BELL TELEPHONE OF PENNSYLVANIA
MARCH 1979

I. SYSTEM DESCRIPTION

The Bell Telephone of Pennsylvania site is a one-story office and warehouse building in West Chester County, Pennsylvania. The solar energy system is designed to supply approximately 62 percent of the annual space heating requirements for the building. The site has an array of Heliotherm flat-plate collectors with a gross area of 2,112 square feet that faces south at an angle of 55 degrees from the horizontal. Solar heated water is stored in a 6,000-gallon capacity tank, but contains only 4,600 gallons. The tank is located above ground in the Mechanical room. Thermal energy is distributed to the loads by circulating water from the storage tank through forced-air heat exchangers and through 20 individual heat pump evaporators. When solar energy is insufficient to meet the needs for space heating, auxiliary energy is supplied to the circulating water by electric resistance heating in the boiler.

The system, shown schematically in Figure 1, has three instrumented modes of solar operation.

Mode 1 - Collector-to-Storage: This mode is entered when the collector absorber plate temperature exceeds the temperature in the middle of storage by at least 18°F. Water from the tank is then circulated through the collectors until this temperature differential is less than 3°F. The collector subsystem has a drain-down feature to prevent freezing. Overheat protection is provided by automatic draining of the collector array whenever the collector output temperature exceeds 190°F.

Mode 2 - Storage-to-Space Heating: This mode is entered with a demand for heating from manually preset thermostats in either the office corridors or the warehouse area. Water is circulated by pumps P3 and P4 between the

• 1081 COLLECTOR PLANE TOTAL INSOLATION
 ▲ 1028 INDOOR TEMPERATURE

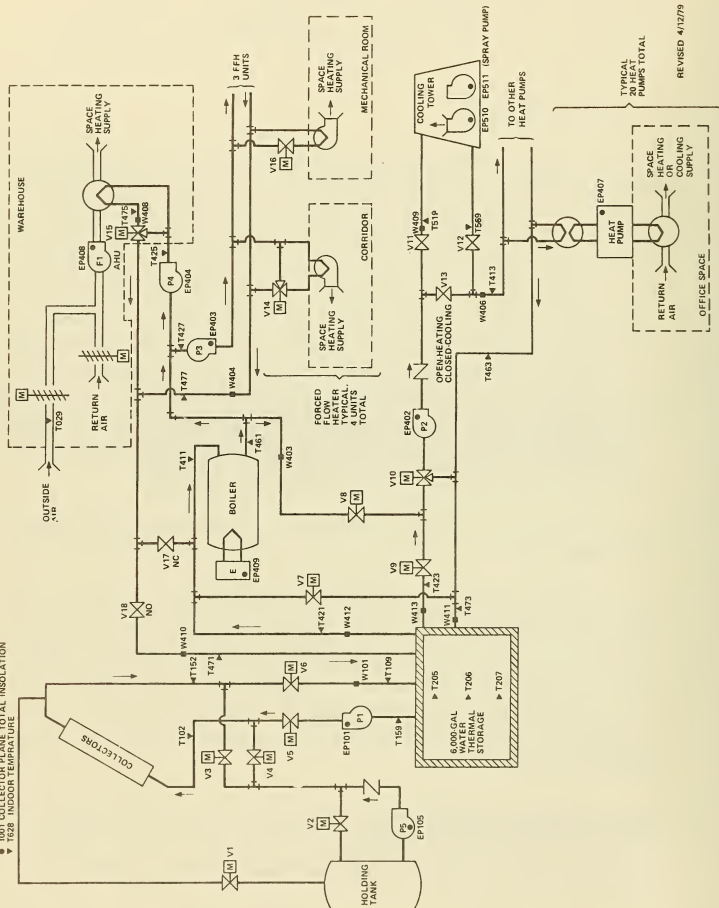


Figure 1. BELL TELEPHONE SOLAR ENERGY SYSTEM SCHEMATIC

REVISED 4/12/79

storage tank and the air-handling unit (AHU) heat exchangers and the forced flow heater (FFH) units. The AHU and the FFH units are activated to provide heat to the warehouse area and the corridors, respectively. Pumps P3 and P4 are deactivated whenever the space heating demands are satisfied at each respective area.

Mode 3 - Storage-to-Space Heating (Heat Pumps): This mode is entered when there is a demand for space heating from individual offices, and the sensed temperature of the water to the heat pumps is below a nominal 70°F. Valve V10 blends water from the storage tank with the heat pump recirculation flow as required. Flow from the storage tank ceases when the heat pump fluid operating temperature again reaches the 70°F set point. When the sensed storage tank temperature is less than 70°F, the boiler then becomes the thermal energy source for the heat pumps by the opening of valve V8 and the closing of valve V9.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data. The performance factors discussed in this report are based upon the definitions contained in NBSIR-76-1137, Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

The solar energy system at the Bell Telephone of Pennsylvania site satisfied 69 percent of the measured space heating load (14.88 million Btu) during March. The solar energy system saved 7.23 million Btu of electrical energy. The system operation was interrupted by a cooling tower rupture on March 31, which subsequently allowed pump P2 to empty the storage tank.

B. Weather

The March outside temperatures averaged 9°F warmer than the long-term average temperature of 42°F as reported in the National Oceanic and Atmospheric Administration Bulletin for the Philadelphia International Airport. The measured insolation in the plane of the collector array averaged 1,412 Btu/ft²-day, which is slightly higher than the long-term average of 1,322 Btu/ft²-day as estimated for the area from the Climatic Atlas of the United States.

C. System Thermal Performance

Collector - The solar energy system collected 21.90 million Btu, or 24 percent of the 92.47 million Btu of the incident insolation on the collector array. The collector array efficiency is 25 percent lower than the value computed for February. The primary factors that adversely affected the collector array performance for March included: reduced collector pump operation from March 20 through March 23 to avoid over heating the storage tank, average storage tank temperatures were 36°F higher for March than for February, and reduced collector pump operation due to drain and fill control problems. A total of 55.72 million Btu of insolation was incident when the collector pump P1 was operating. The operation of collector pump P1 and refill pump P5 required 0.57 million Btu of electrical operating energy.

Storage - A total of 23.52 million Btu of thermal energy was added to storage from two sources during the month. The solar energy system provided 21.90 million Btu. The electric boiler added 1.62 million Btu, due to the circulation of storage water between the boiler and storage. A total of 19.60 million Btu of thermal energy was extracted from storage during the month. Of this amount, 13.10 million Btu were supplied to the source water for heating the warehouse and the office building corridors. The remaining 6.50 million Btu were supplied to the continuous recirculation loop for the 20 heat pump units. The storage energy level increased by 0.28 million Btu. The energy loss from storage was 3.64 million Btu, which was computed by subtracting

the sum of the change in storage energy and the energy removed from storage from the total thermal energy delivered to storage. The storage tank losses increased by 2.36 million Btu over February due to the significantly higher storage temperatures and partially due to the uncontrolled removal of storage energy when the cooling tower heat exchanger ruptured on March 31.

Space Heating Load - The measured space heating load was 14.88 million Btu. The solar energy system provided 19.26 million Btu of energy to the space heating subsystem. Of this amount, only 10.27 million Btu of solar energy were used to satisfy system loads. The solar fraction of the space heating load was 69 percent. The remaining 8.99 million Btu of solar energy removed from storage was apparently added to the interior of the building through pipe losses. The electric boiler and the heat pump compressors provided an additional 5.32 million Btu of thermal energy to the space heating subsystem. The operation of circulating pumps P2, P3, and P4, the AHU fan F1, and the FFH unit fans required 3.27 million Btu of electrical energy.

D. Observations

The warmer March outside temperatures necessitated the manual switching of the system operation from the winter to the summer mode on March 21. In the summer mode, valve V10 is held closed to the storage and boiler heat source lines and fully open to the heat pump return line. In addition, valve V13 is closed and valves V11 and V12 are opened to allow heat pump loop water to flow through the cooling tower located in the building's mechanical room. The system remained in the summer mode through March 31.

The solar energy collection system was operated manually on March 28 due to a control failure that prevented the collectors from draining whenever outside temperatures fell below the nominal 45°F control setting. In addition, manual intervention was required to transfer heat, via valve V10, from the storage tank to the heat pump loop as required to satisfy space heating demands on the heat pumps.

On March 31 at 6:31 p.m., water apparently began to be expelled from the heat pump loop at a rate of 32 gallons per minute as calculated by differencing the flow measurements W409 and W406. The water temperature measured by sensor T519 jumped from 80°F to 143°F. At 9:06 p.m. the flow as measured by both W409 and W406 became zero. In an apparently related event, the collector refill pump P5 was activated at 6:36 and attempted unsuccessfully to fill the collector arrays. The cause of these events is under investigation. The site contractor indicated that the heat pump loop circulating pump P2 operated to empty the 4,600-gallon water storage tank onto the mechanical room floor. The energy content of the expelled storage water was estimated to be approximately 4.0 million Btu.

The conventional method for the calculation of the thermal energy removed from storage and delivered to the heat pump loop was unsatisfactory this month because of an incompatibility between the measurement range of flow sensor W413 and the range of the actual flow to be measured. Consequently, an alternate procedure was used to estimate the amount of energy removed from storage and delivered to the heat pump loop. By establishing a thermal energy balance at the storage tank on an hourly basis, the amount of energy delivered to the heat pump loop was calculated. To establish this balance, the storage heat loss rate was determined at a time when no energy was being added or removed from storage. Using measurement data from the September, 1978 Bell Telephone of Pennsylvania Performance Report, the storage heat loss rate was determined to be 50.33 Btu/°F-hour. Using this heat loss rate in conjunction with other storage measurements, storage energy balances were obtained. Occasionally, negative energy tabulations of solar energy used will be obtained on a daily basis using this computed energy from storage parameter. The negative tabulations of solar energy used on March 6 and 7 illustrate this problem. These results are inherent in the calculations. However, because of the cancelling effects of the positive and negative values for this parameter, the monthly errors are expected to be small. A total of 6.50 million Btu of storage energy was contributed to the heat pump loop.

E. Energy Savings

The Bell Telephone of Pennsylvania solar energy system saved 7.23 million Btu of electrical energy during March. The reported savings were based on the amount of solar energy utilized to satisfy calculated heating loads.

III. ACTION STATUS

A site visit was made by IBM personnel on March 15 to investigate the flow incompatibility problem of flow sensor W413 and also to implement the latest measurement improvements. The problem with the measurement of flow at W413 could not be resolved without replacing the flow sensor with one of lower range. This action would require a smaller pipe size which might impact the system operation. Consequently, the current method of calculating the amount of thermal energy delivered to the heat pump loop will be continued.

Site personnel indexed the heat pump system to summer operation on March 21. The solar energy system was not fully operational on March 28 due to testing of the automatic collector drain and fill control system.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979

SOLAR/2012-75/03

SITE/SYSTEM DESCRIPTION:

THE BELL TELEPHONE SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING FOR A
FOR SOLAR COLLECTOR BUILDING. THE SOLAR ENERGY SYSTEM USES WATER
FOR ENERGY COLLECTION, TRANSFER AND STORAGE. HOT WATER FROM THE STORAGE
TANK IS DIRECTED TO A WATER-TIGHT HEAT PUMP LOOP AND AN AIR-DUCT
W/ LOOP FOR SPACE HEATING. AN ELECTRIC BOILER PROVIDES AUXILIARY EN-
ERGY.

GENERAL SITE DATA:

INCIDENTAL SOLAR ENERGY
COLLECTED SOLAR ENERGY
AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECS SOLAR CONVERSION EFFICIENCY
ECS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

52.467 MILLION BTU
43762 BTU/SQ.FT.
21.501 MILLION BTU
10370 BTU/SQ.FT.
51 DEGREES F
68 DEGREES F
0.19
0.570 MILLION BTU
3.838 MILLION BTU
31.723 MILLION BTU

SUBSYSTEM SUMMARY:

LOAD
SOLAR FRACTION
SOLAR ENERGY USED
OPERATING ENERGY
AUX. THERMAL ENERGY
AUX. ELECTRIC FUEL
AUX. FOSSIL FUEL
ELECTRICAL SAVINGS
FOSSIL SAVINGS

HOT WATER
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

HEATING
14.883
69
17.981
3.269
5.320
5.984
N.A.
7.803
N.A.

COOLING
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

SYSTEM TOTAL
14.883 MILLION BTU
69 PERCENT
17.981 MILLION BTU
3.838 MILLION BTU
5.320 MILLION BTU
5.984 MILLION BTU
N.A. MILLION BTU
7.233 MILLION BTU
N.A. MILLION BTU

SYSTEM PERFORMANCE FACTOR:

0.455

* DENOTES UNAVAILABLE DATA

@ DENOTES NULL DATA

N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979

SOLAR/2012-75/03

SITE/SYSTEM DESCRIPTION:

THE BELL TELEPHONE SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING FOR A 10,500 SQ. FT. OFFICE BUILDING. THE SOLAR ENERGY SYSTEM USES WATER FOR ENERGY COLLECTION, TRANSFER AND STORAGE. HOT WATER FROM THE STORAGE TANK IS DIRECTED TO A WATER-TO-AIR HEAT PUMP LOOP AND TO AN AIR-DUCT HX LOOP FOR SPACE HEATING. AN ELECTRIC FILLER PROVIDES AUXILIARY ENERGY.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY 97.553 GIGA JOULES
COLLECTED SOLAR ENERGY 497188 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE 23.106 GIGA JOULES
AVERAGE BUILDING TEMPERATURE 117760 KJ/SQ.M.
ECS SOLAR CONVERSION EFFICIENCY 10 DEGREES C
ECS OPERATING ENERGY 20 DEGREES C
TOTAL SYSTEM OPERATING ENERGY C.19
TOTAL ENERGY CONSUMED 0.601 GIGA JOULES
33.468 GIGA JOULES

SURSYSTEM SUMMARY:

LOAD FRACTION N.A.
SOLAR ENERGY USED N.A.
OUTRAID ENERGY N.A.
AUX. THERMAL ENRG N.A.
AUX. FUELS N.A.
FUELS N.A.
ELECTRICAL SAVINGS N.A.
FOSSIL SAVINGS N.A.

HEATING 15.702
18.979
5.748
5.612
6.313
N.A.
8.232
N.A.
0.455

COOLING N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

SYSTEM TOTAL 15.701 GIGA JOULES
PERCENT 18.979
4.045 GIGA JOULES
5.612 GIGA JOULES
6.313 GIGA JOULES
N.A.
7.631 GIGA JOULES
N.A.

SYSTEM PERFORMANCE FACTOR:

* DENOTES UNAVAILABLE DATA
Ø DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978.
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979

SOLAR/2012-79/03

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	2.156	51	0.845	0.000	0.018	N	0.392
2	2.375	52	0.958	0.000	0.018	D	0.391
3	0.304	50	0.762	0.021	0.000	T	0.455
4	0.228	54	0.739	0.304	0.005		0.113
5	0.337	60	0.300	0.040	0.000	A	0.444
6	0.060	55	0.258	0.469	0.000	P	-0.887
7	1.701	48	0.544	0.396	0.016	P	-0.006
8	4.279	49	1.233	0.195	0.037	L	0.243
9	4.173	52	0.997	0.000	0.035	I	0.229
10	*	*	*	*	*	C	*
11	2.935	35	1.308	0.000	0.021	A	0.446
12	3.901	35	1.172	0.139	0.029	B	0.265
13	3.869	51	0.799	0.000	0.031	L	0.206
14	1.093	55	0.350	0.000	0.004	E	0.231
15	4.824	30	1.457	0.000	0.032		0.302
16	4.582	38	1.193	0.000	0.035		0.260
17	4.381	52	0.731	0.000	0.033		0.167
18	4.601	53	0.455	0.000	0.031		0.059
19	4.722	51	0.923	0.000	0.031		0.156
20	4.933	52	0.633	0.000	0.031		0.128
21	4.345	55	0.360	0.000	0.019		0.083
22	4.416	56	0.219	0.000	0.014		0.050
23	4.508	60	0.150	0.000	0.009		0.033
24	0.346	61	0.018	0.000	0.000		0.031
25	2.059	50	0.169	0.000	0.003		0.052
26	2.087	38	0.734	0.000	0.001		0.252
27	3.089	38	0.790	0.000	0.020		0.236
28	5.076	45	0.706	0.000	0.011		0.173
29	3.353	60	0.112	0.000	0.021		0.009
30	2.135	59	0.013	0.000	0.007		0.009
31	2.234	68	0.433	0.000	0.029		0.192
SUM	92.467	-	19.598	1.617	0.570	N.A.	-
AVG	2.983	51	0.632	0.052	0.018	N.A.	0.154
NBS ID	0001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.

@ DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT COLLECTOR ARRAY PERFORMANCE

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979

SOLAR/2012-75/03

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	2.156	1.366	0.656	55	0.304
2	2.205	1.603	0.752	53	0.330
3	0.308	0.109	0.019	50	0.100
4	0.728	0.316	0.119	55	0.102
5	0.327	0.000	0.000	64	0.000
6	0.060	0.000	0.000	54	0.000
7	1.701	0.767	0.325	50	0.191
8	4.279	3.632	2.031	52	0.475
9	4.173	3.642	1.754	52	0.420
10	*	*	*	*	*
11	2.935	1.631	0.721	35	0.246
12	3.901	3.061	1.441	36	0.369
13	3.869	3.205	1.461	54	0.378
14	1.093	0.223	0.122	61	0.112
15	4.824	3.722	1.396	28	0.289
16	4.582	3.905	1.661	38	0.363
17	4.387	3.668	1.522	52	0.347
18	4.601	3.460	1.149	54	0.250
19	4.722	3.578	1.247	51	0.264
20	4.932	3.656	1.117	55	0.226
21	4.345	2.156	0.644	59	0.148
22	4.416	1.513	0.397	63	0.090
23	4.508	1.071	0.282	66	0.062
24	0.346	0.000	0.000	60	0.000
25	2.029	0.157	-0.006	53	-0.023
26	2.087	0.014	0.000	39	0.000
27	3.089	1.370	0.386	40	0.125
28	5.076	1.021	0.262	48	0.052
29	3.353	2.605	1.110	62	0.331
30	2.135	1.141	0.347	73	0.162
31	2.254	1.152	0.340	76	0.151
SUM	92.467	55.718	21.901	-	-
AVG	2.983	1.797	0.706	53	0.237
NBSID	0001		0100		N100

* DENOTES UNAVAILABLE DATA.

@ DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT STORAGE PERFORMANCE

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979
SOLAR/2012-79/02

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORAGE ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.656	0.846	-0.259	131	0.834
2	0.752	0.858	-0.206	125	0.906
3	0.722	0.722	0.000	110	-1.600
4	0.422	0.536	-0.737	110	0.869
5	0.046	0.300	-0.256	98	0.000
6	0.469	0.258	0.173	98	0.518
7	0.721	0.544	0.140	101	0.960
8	1.233	0.597	0.942	116	0.937
9	1.755	0.597	0.678	134	0.955
10	0.721	1.308	-0.672	*	*
11	1.580	1.799	-0.781	121	0.732
12	1.461	0.799	0.348	115	0.562
13	0.122	0.350	-0.589	128	0.549
14	1.396	1.457	-0.307	133	0.351
15	1.661	1.193	0.134	128	0.548
16	1.522	0.731	0.398	128	0.558
17	1.149	0.455	0.698	145	0.939
18	1.247	0.923	0.577	163	0.898
19	1.117	0.633	0.197	173	0.899
20	0.644	0.360	0.329	182	0.862
21	0.397	0.219	0.141	188	0.778
22	0.282	0.150	0.033	190	0.636
23	0.000	0.018	-0.014	191	0.480
24	-0.046	0.169	-0.165	189	1.000
25	0.000	0.734	-0.355	181	4.081
26	0.386	0.790	-0.850	163	1.000
27	0.262	0.706	-0.496	145	0.759
28	1.110	0.112	-0.503	130	0.775
29	0.347	0.019	-0.867	137	0.862
30	0.340	0.433	-0.230	152	0.717
31	23.518	19.598	-0.197	158	0.656
SUM	0.759	0.632	0.275	-	-
AVG	Q200	Q201	0.009	142	0.845
NBS ID			G202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SPACE HEATING SUBSYSTEM

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979

SCLAF/2012-79/03

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR HEATING LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	ALX THERMAL MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AIR TEMP DEG. F
1	0.644	88	0.845	0.177	0.112	0.161	N	0.334	0.334	74	51
2	0.804	92	0.958	0.155	0.063	0.090	C	0.617	0.617	67	52
3	0.789	83	0.741	0.197	0.136	0.165	T	0.517	0.517	69	50
4	0.494	11	0.083	0.050	0.620	0.062	A	0.056	0.056	62	54
5	0.419	43	0.211	0.102	0.268	0.303	A	0.079	0.079	67	60
6	0.605	4	-0.053	0.120	0.874	0.895	P	0.000	0.000	66	55
7	0.772	6	-0.009	0.177	0.904	0.936	P	0.035	0.035	71	48
8	1.198	54	1.039	0.261	0.662	0.707	P	0.495	0.495	74	49
9	0.614	93	0.997	0.138	0.053	0.076	I	0.456	0.456	69	52
10	0.864	100	1.308	0.054	0.000	0.000	C	0.864	0.864	64	35
11	1.195	54	1.033	0.208	0.669	0.716	A	0.488	0.488	65	35
12	0.614	85	0.799	0.162	0.081	0.115	B	0.367	0.367	67	35
13	0.269	76	0.350	0.089	0.044	0.063	L	0.137	0.137	68	35
14	1.007	86	1.457	0.216	0.153	0.219	E	0.505	0.505	67	30
15	0.927	84	1.193	0.225	0.133	0.190		0.513	0.513	70	30
16	0.580	82	0.731	0.199	0.106	0.151		0.277	0.277	67	32
17	0.302	86	0.455	0.120	0.044	0.062		0.161	0.161	67	33
18	0.444	80	0.923	0.095	0.055	0.078		0.283	0.283	68	31
19	0.214	76	0.633	0.063	0.026	0.038		0.120	0.120	70	35
20	0.166	57	0.360	0.075	0.042	0.062		0.035	0.035	70	35
21	0.067	80	0.150	0.032	0.014	0.020		0.028	0.028	70	36
22	0.077	46	0.150	0.034	0.012	0.017		0.033	0.033	70	30
23	0.028	39	0.018	0.016	0.007	0.010		0.004	0.004	67	31
24	0.098	89	0.169	0.008	0.003	0.004		0.004	0.004	65	30
25	0.247	97	0.734	0.025	0.003	0.004		0.235	0.235	67	38
26	0.352	97	0.790	0.025	0.002	0.003		0.335	0.335	68	38
27	0.474	94	0.706	0.060	0.025	0.035		0.357	0.357	68	45
28	0.093	56	0.112	0.048	0.024	0.034		0.019	0.019	68	40
29	0.035	51	0.019	0.020	0.009	0.012		0.006	0.006	67	39
30	0.013	50	0.433	0.012	0.003	0.005		0.003	0.003	72	39
SUM	14.883	--	17.981	3.269	5.320	5.984	N.A.	7.803	N.A.	--	--
AVG	0.480	69	0.580	0.105	0.172	0.193	N.A.	0.252	N.A.	68	51
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT ENVIRONMENTAL SUMMARY

SITE: BELL TELEPHONE OF PENNSYLVANIA
REPORT PERIOD: MARCH, 1979

SOLAR/2012-79/03

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	1021	N	51	55	N	N	N
2	1077	T	52	50	T	C	T
3	1044		50	55			
4	345		55	55			
5	155	A	60	64	A	A	A
6	128	P	50	54	P	P	P
7	805	L	48	50	L	L	L
8	2026	I	49	52	I	I	I
9	1976	C	52	52	C	C	C
10	*	A	*	*	A	A	A
11	1390	P	35	35	P	P	P
12	1847	L	35	36	L	L	L
13	1832	A	51	54	A	A	A
14	518	P	55	61	P	P	P
15	2284	I	30	28	I	I	I
16	2169	C	38	38	C	C	C
17	2077	A	52	52	A	A	A
18	2179	P	53	54	P	P	P
19	2236	L	51	51	L	L	L
20	2335	I	55	55	I	I	I
21	2057	C	55	59	C	C	C
22	2091	A	63	63	A	A	A
23	2135	P	56	66	P	P	P
24	164	L	60	60	L	L	L
25	960	A	61	60	A	A	A
26	988	P	50	53	P	P	P
27	1462	I	38	39	I	I	I
28	2403	C	45	40	C	C	C
29	1588	A	60	48	A	A	A
30	1011	P	69	72	P	P	P
31	1067	L	68	76	L	L	L
SUM	43782	N.A.	-	-	-	-	-
AVG	1412	N.A.	51	53	N.A.	N.A.	N.A.
NBS ID	0001		N113		N115	N114	

* DENOTES UNAVAILABLE DATA.

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